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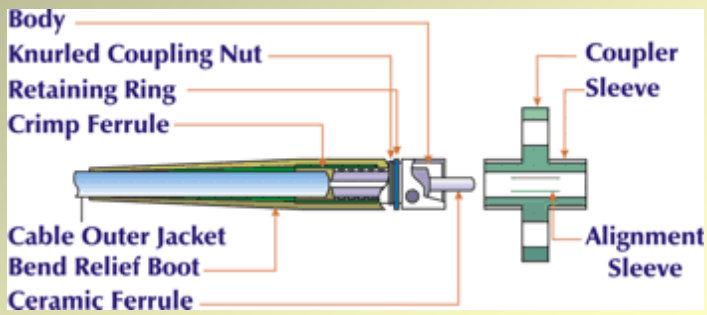
Connectors

A mechanical or optical device that provides a demountable connection between two fibers or a fiber and a source or detector.

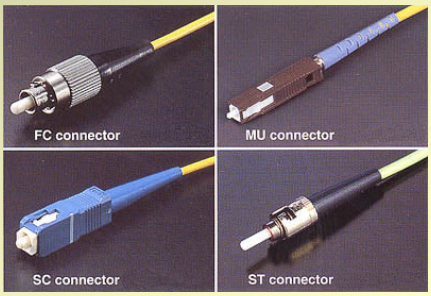


Connectors - *contd.*

Type: SC, FC, ST, MU, SMA

- Favored with single-mode fibre
- Multimode fibre (50/125um) and (62.5/125um)
- Loss 0.15 - 0.3 dB
- Return loss 55 dB (SMF), 25 dB (MMF)

Single fibre connector



Connectors - *contd.*

- Single-mode fiber
- Multi-mode fiber (50/125)
- Multi-mode fiber (62.5/125)
- Low insertion loss & reflection

MT-RJ Patch Cord

MT-RJ Fan-out Cord

Optical Splices

- Mechanical
  - Ends of two pieces of fiber are cleaned and stripped, then carefully butted together and aligned using a mechanical assembly. A gel is used at the point of contact to reduce light reflection and keep the splice loss at a minimum. The ends of the fiber are held together by friction or compression, and the splice assembly features a locking mechanism so that the fibers remained aligned.
- Fusion
  - Involves actually melting (fusing) together the ends of two pieces of fiber. The result is a continuous fiber without a break.

Both are capable of splice losses in the range of 0.15 dB (3%) to 0.1 dB (2%).

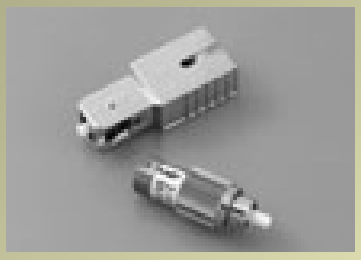
Attenuators

Singlemode Variable Attenuator

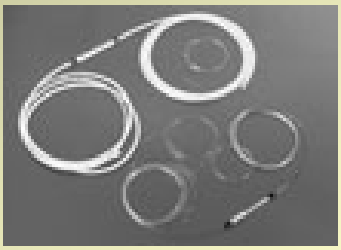
- Repeatable, variable attenuation from 2 to 40dB
- <-70dB reflectance (unconnectorized)
- Polarization insensitive
- Low modal noise
- Long-term reliability

Attenuators - *contd.*

Dual window



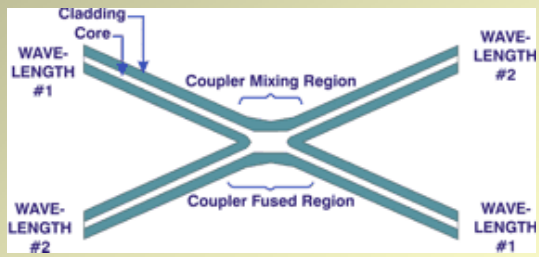
In line attenuator

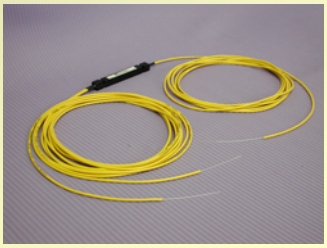


- Bandpass 1310/1550nm
- FC, SC, ST, and D4 styles
- Wavelength independent
- Polarization insensitive
- Low modal noise

Optical Couplers

- Optic couplers either split optical signals into multiple paths or combine multiple signals on one path.
- The number of input (N)/ output (M) ports, (i.e.s N x M size) characterizes a coupler.
- Fused couplers can be made in any configuration, but they commonly use multiples of two (2 x 2, 4 x 4, 8 x 8, etc.).

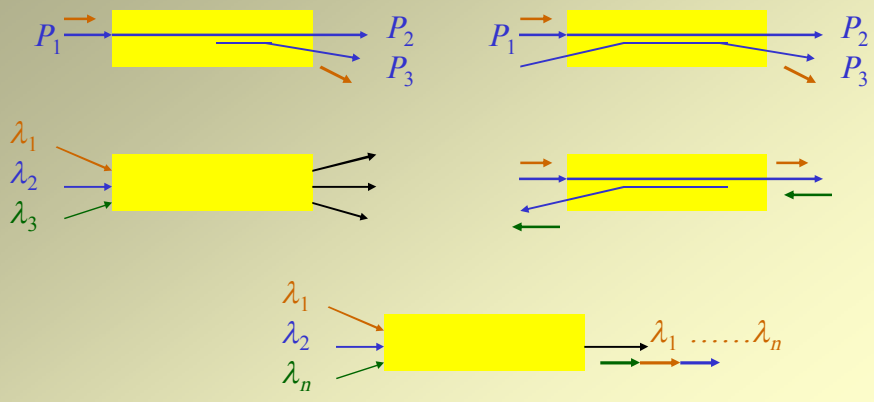




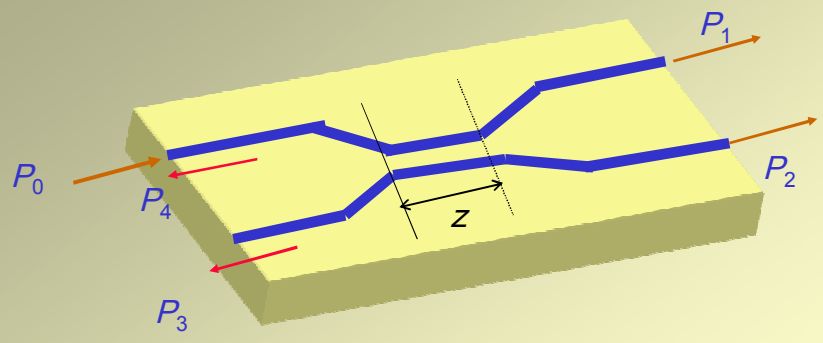
Coupler

- **Uses**
  - Splitter: (50:50)
  - Taps: (90:10) or (95:05)
  - Combiners
- **An important issue:**
  - two output differ **π/2** in phase
- **Applications:**
  - Optical Switches,
  - Mach Zehnder Interferometers,
  - Optical amplifiers,
  - passive star couplers, ...

Coupler Configuration



Coupler - Integrated Waveguide Directional Coupler

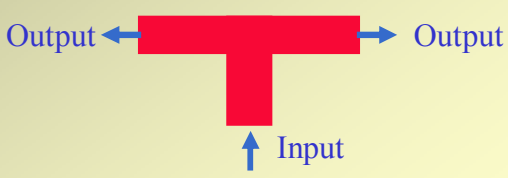


$P_2 = P_0 \sin^2 kz$ $\quad P_1 = P_0 - P_2 = P_0 \cos^2 kz$

k = coupling coefficient = $(m + 1)\pi/2$

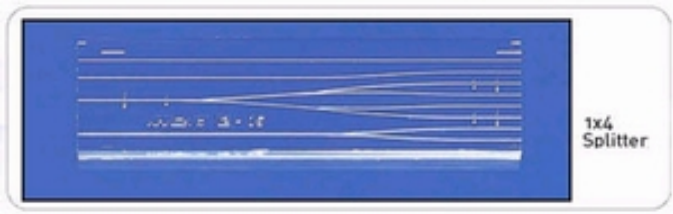
Splitters

- The simplest couplers are fiber optic splitters.
- They possess at least three ports but may have more than 32 for more complex devices.
- Popular splitting ratios include 50%-50%, 90%-10%, 95%-5% and 99%-1%; however, almost any custom value can be achieved.
- Excess loss: assures that the total output is never as high as the input. It hinders the performance. All couplers and splitters share this parameter.
- They are symmetrical. For instance, if the same coupler injected 50 µW into the 10% output leg, only 5 µW would reach the common port.



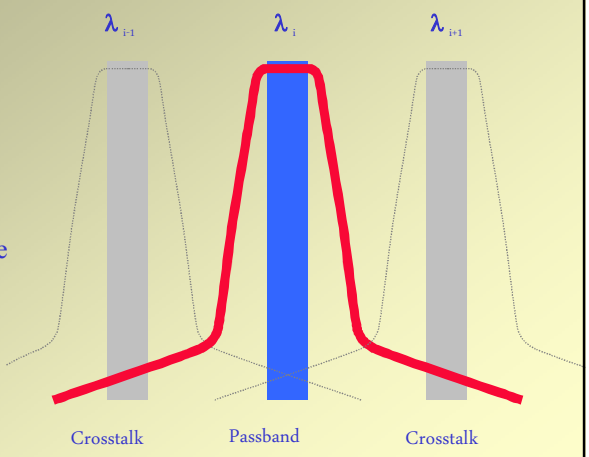
Coupler + Splitter - Applications

- Local monitoring of a light source output (usually for control purposes).
- Distributing a common signal to several locations simultaneously.



Optical Filters

- **Passband**
  - Insertion loss
  - Ripple
  - Wavelengths (peak, center, edges)
  - Bandwidths (0.5 dB, 3 dB, ..)
  - Polarization dependence
- **Stopband**
  - Crosstalk rejection
  - Bandwidths
  - (20 dB, 40 dB, ..)



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Optical Isolators

- Only allows transmission in one direction through it **Main application:** To protect lasers and optical amplifiers from returning reflected light, which can cause instabilities

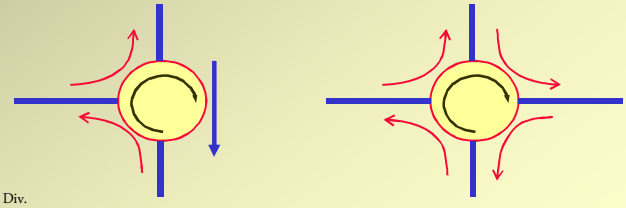
- **Insertion loss:**
  - Low loss (0.2 to 2 dB) in forward direction
  - High loss in reverse direction:
    20 to 40 dB single stage, 40 to 80 dB dual stage)

- **Return loss:**
  - More than 60 dB without connectors

Optical Circulators

- Based on optical crystal technology similar to isolators
  - Insertion loss 0.3 to 1.5 dB, isolation 20 to 40 dB

- Typical configuration: 3 port device
  - Port 1 -> Port 2
  - Port 2 -> Port 3
  - Port 3 -> Port 1



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